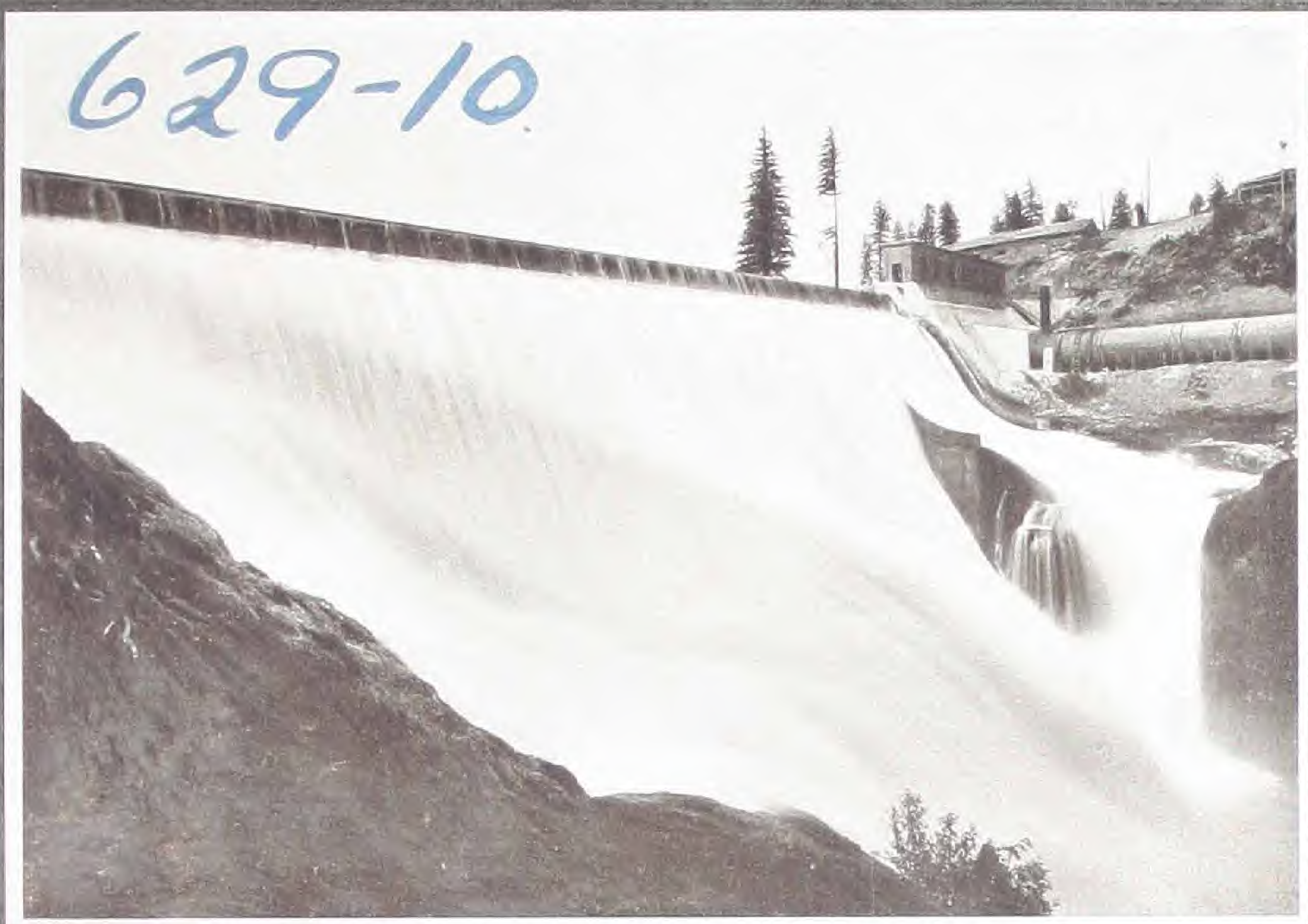
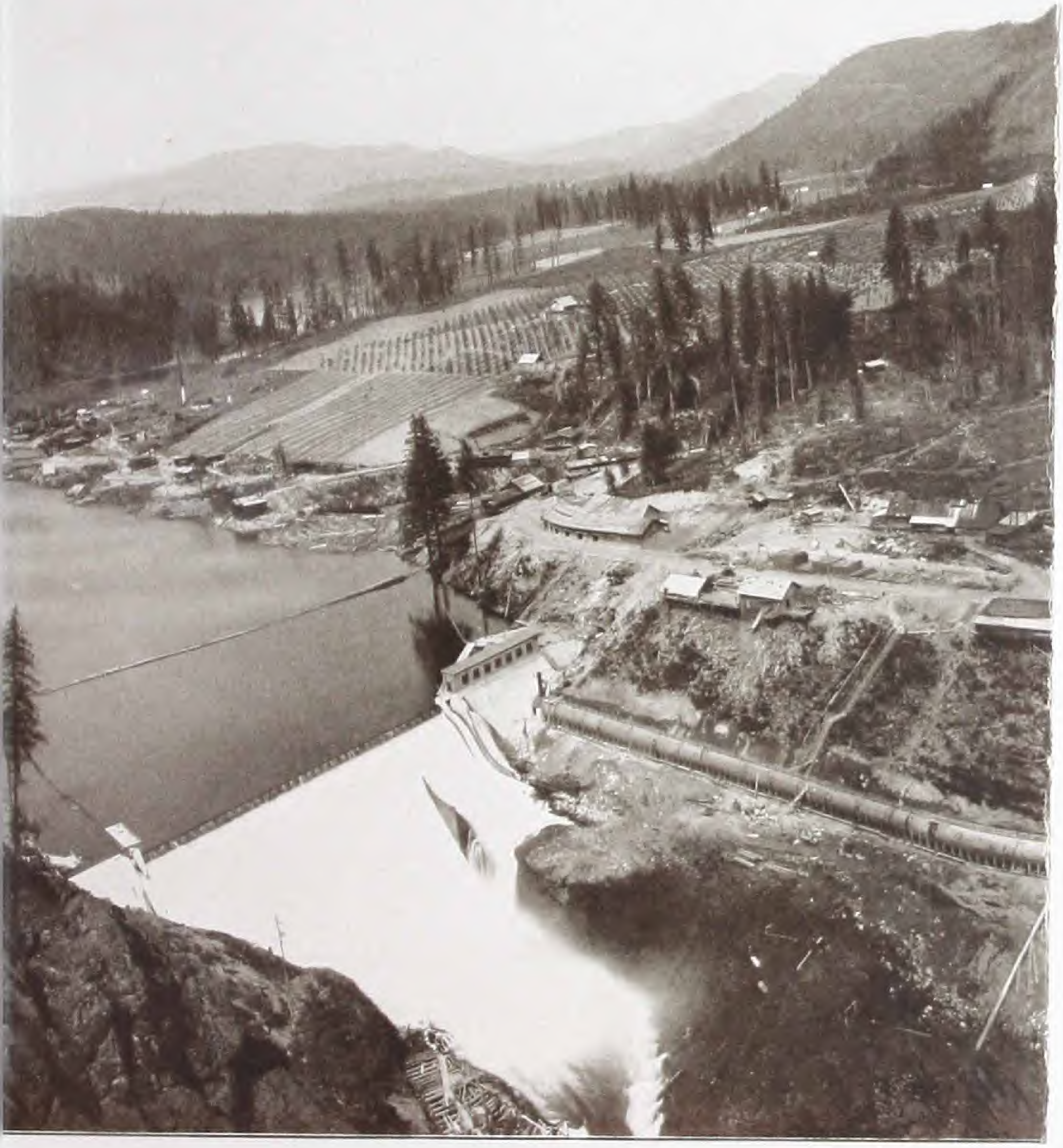


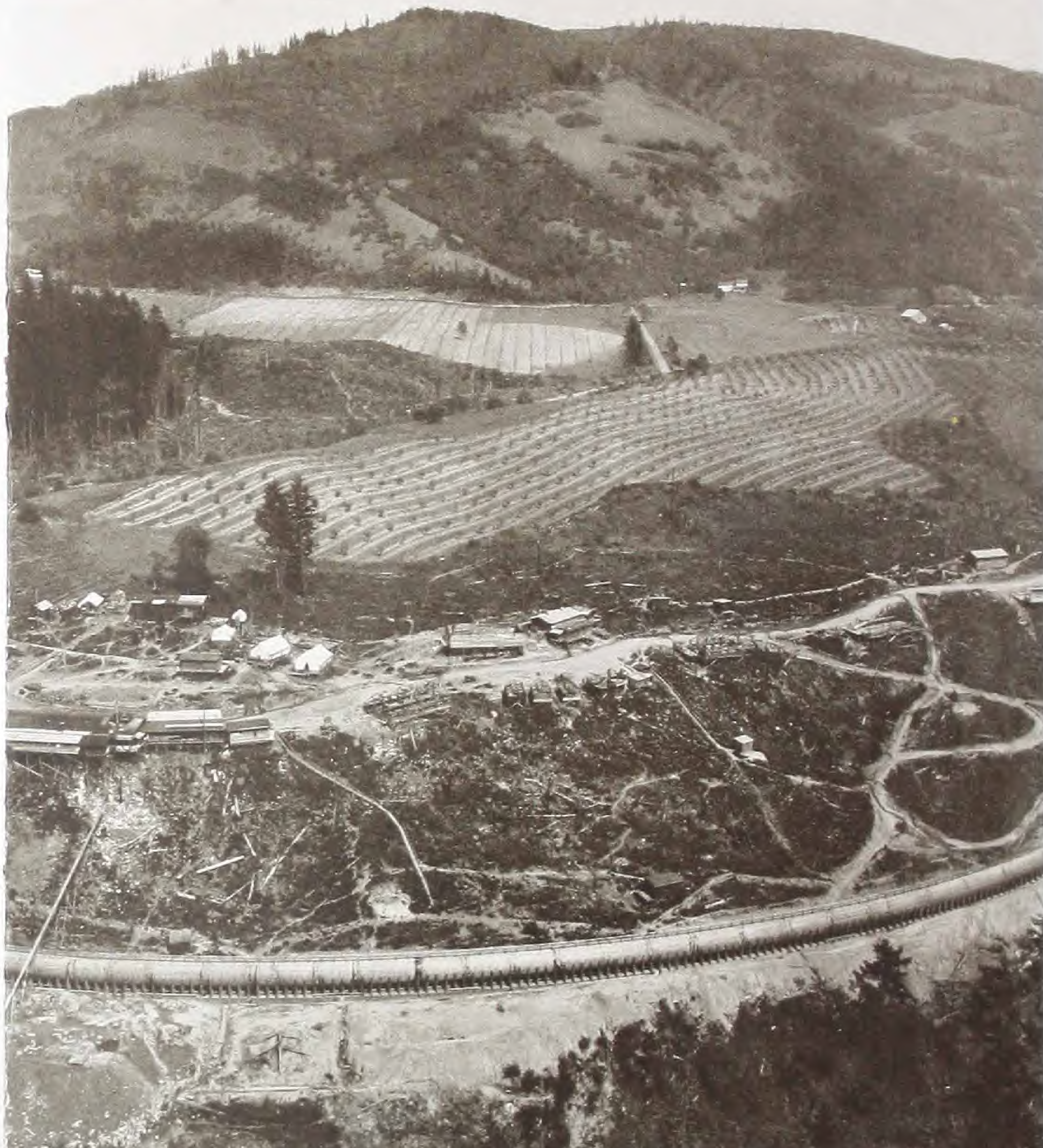
THE CONDIT PLANT OF NORTHWESTERN ELECTRIC COMPANY

PORTLAND, OREGON



NORTHWESTERN ELECTRIC CO. **PANORAMA OF TI**

Looking east across the White Salmon River Valley in southern W
opment is visible with the exception of the penstocks and power h
The white concrete structure, just visible above the trees, is the



HE CONDIT PLANT

PORTLAND, OREGON

Vashington, about seventy miles from Portland. The entire devel-
ouse, which lie behind the trees in the gorge at the extreme right.
forebay from which the penstocks descend to the power house.

White Salmon Development
Condit Plant

Northwestern Electric Company
Portland, Oregon

Stone & Webster Engineering Corporation
Constructing Engineers

The Dam During Construction

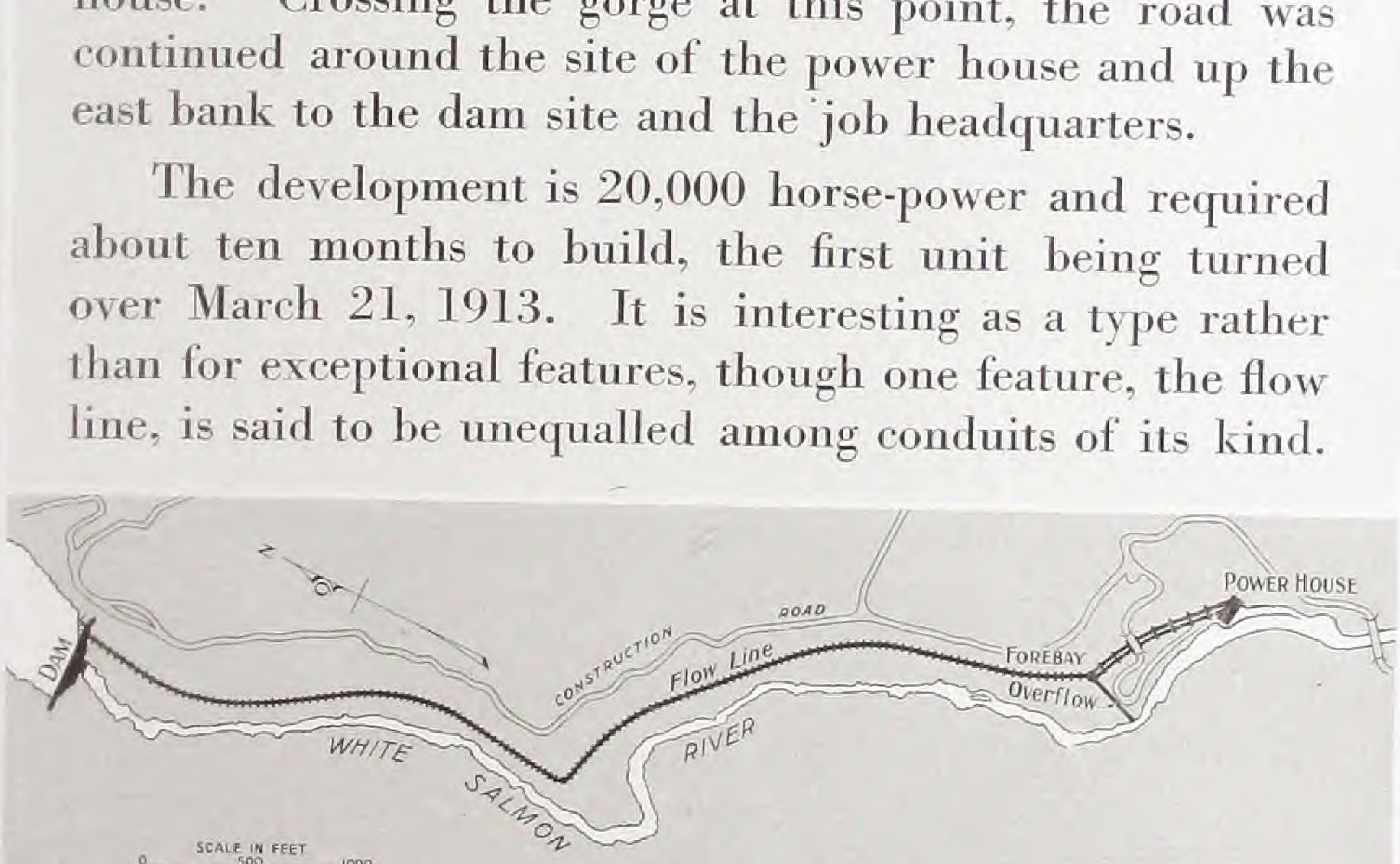
View north looking up the White Salmon River towards the source in the foot-hills of Mt. Adams; in the foreground the temporary power plant fed by the flume tunneled under the dam; on the left hillside the crusher and concrete plant; on the right the headworks and beginning of flow line.

White Salmon Development
Condit Plant

THE White Salmon River rises on Mt. Adams and flows south through the state of Washington, entering the Columbia at a point about seventy miles east of Portland, Oregon. The site of the development, named the Condit Plant after Mr. B. C. Condit of the Northwestern Electric Company, is some three miles up the river and is reached from Underwood on the Spokane, Portland and Seattle Railway, known as the "North Bank" Railroad.

Work began in May, 1912, with the construction of a road from Underwood up the west side of the White Salmon to a point just below the location selected for the power house. Crossing the gorge at this point, the road was continued around the site of the power house and up the east bank to the dam site and the job headquarters.

The development is 20,000 horse-power and required about ten months to build, the first unit being turned over March 21, 1913. It is interesting as a type rather than for exceptional features, though one feature, the flow line, is said to be unequalled among conduits of its kind.



The Diversion Plan

COFFERDAMS diverted the river into a flume which led through two tunnels to a "frog" below the dam, one branch, discharging into the river and the other continuing through Tunnel No. 3 to a temporary power plant. The power flume was provided with a spillway and the flow to the temporary plant was maintained at an elevation of six feet by Tainter gates in both diversion and power flumes. These gates were raised or lowered according to the flow in the flume.

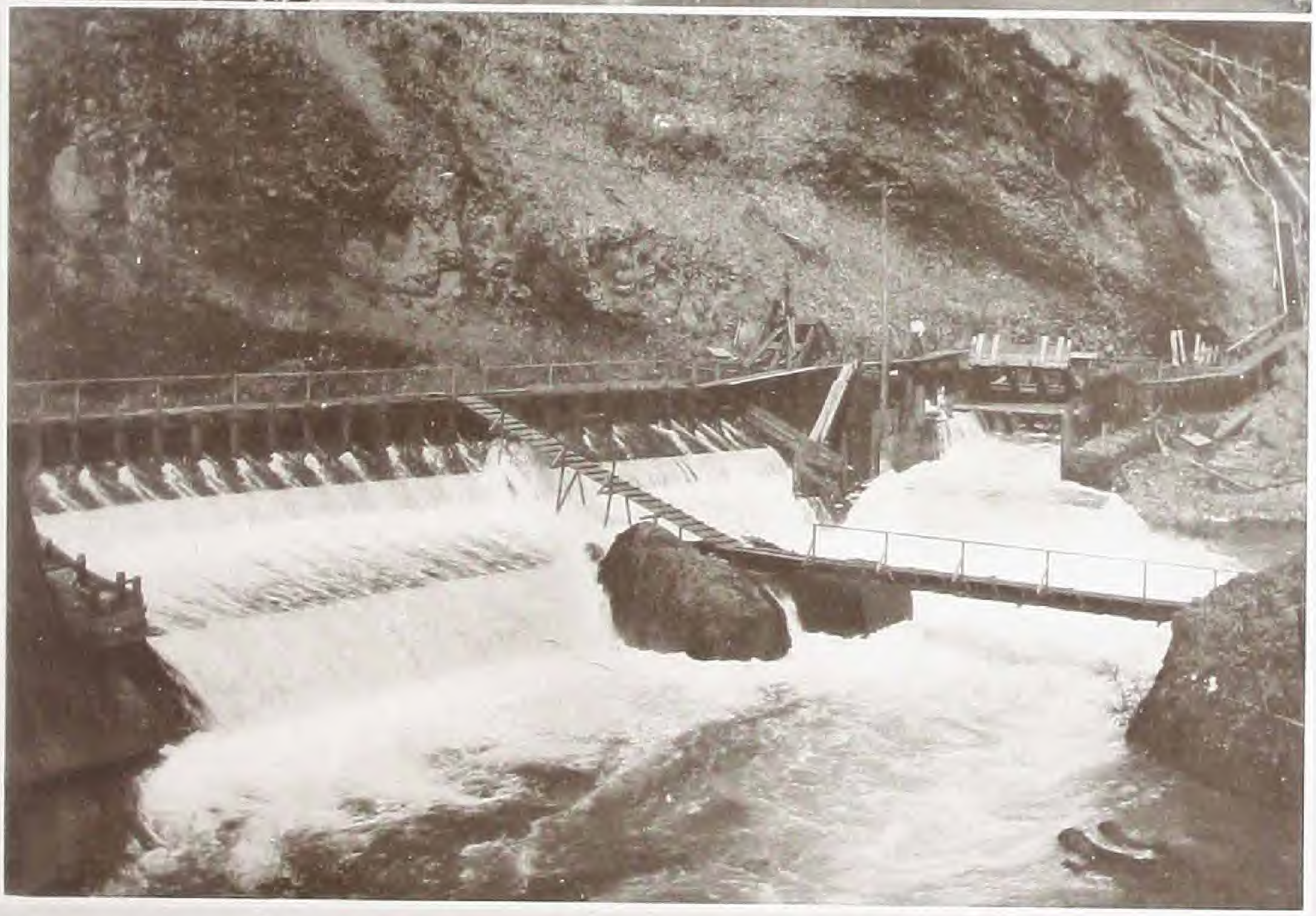
Every part of the diversion scheme was made very strong. The sills of the flume were tamped in place with crushed rock and the sides were box shaped so that they could be ballasted. The main cofferdam was boarded over to form a spillway.

Two 60-inch sluice gates were left in the dam, partly to take care of operating necessity for lowering the pool and partly as a construction expedient.

The flume was built to carry 1,500 second-feet and was provided, at the tunnel which pierces the rock underneath the dam, with a gate which might be closed at any time if the flow became so great as to endanger the temporary power plant below.

The diversion scheme was fully tested by floods. While construction work was at its height and the ground was covered with snow, a down-

Portal of Tunnel No. 3



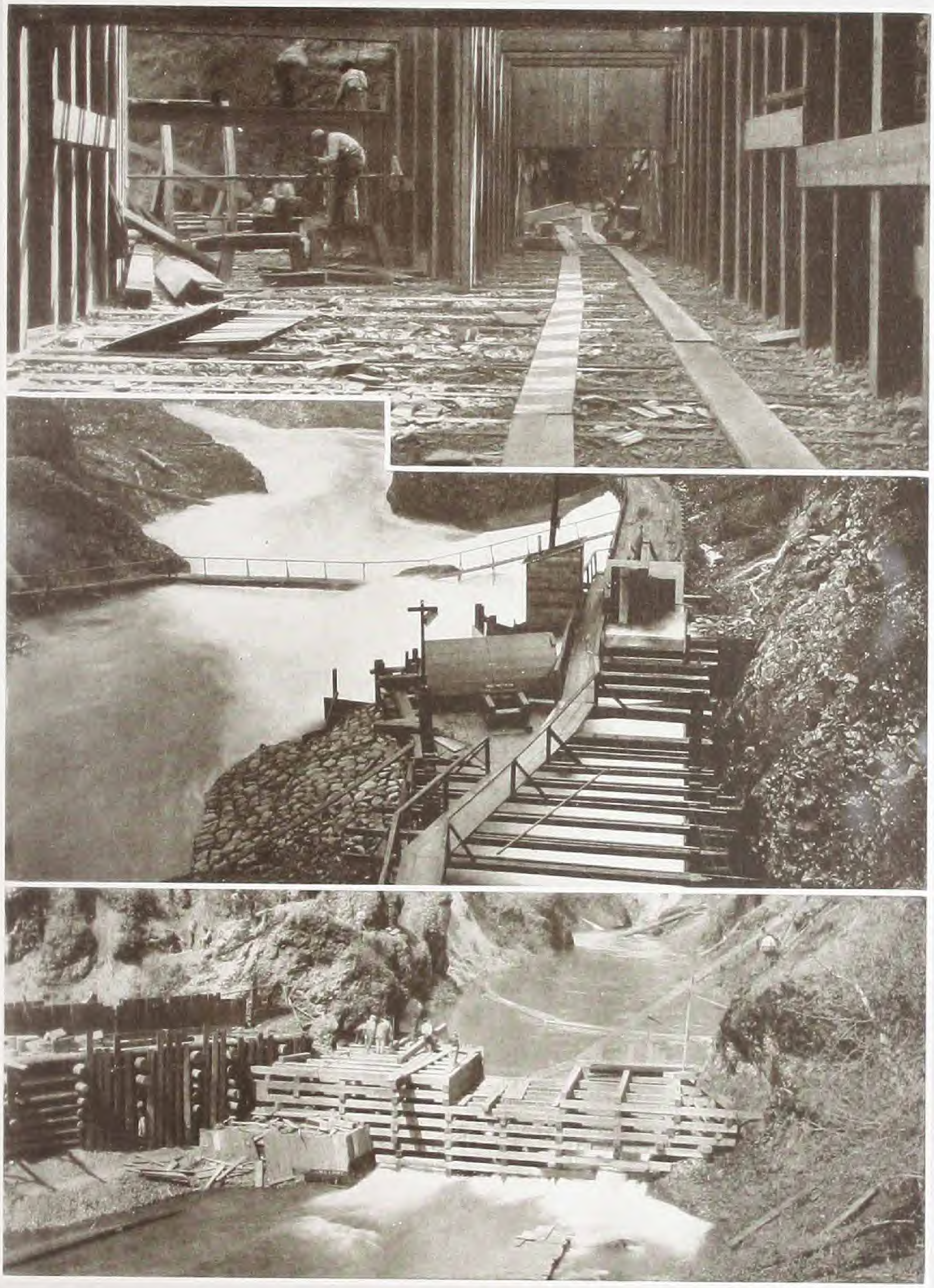
Upper Photograph: Downstream through the dam site, upper end of diversion scheme in foreground, spillway of flume visible beyond. *Lower Photograph:* Spillway of flume and tainter gates for diverting water above temporary power house.

Lowering Generator Stator to Temporary Power Plant

pour of rain caused the river to rise rapidly to about 3,500 second-feet, submerging the flume for forty-eight hours under four feet of water. The water poured over the cofferdam and pooled behind the dam, discharging through the sluice gates and flowing over the sides of the flume where the water had reached its maximum velocity. It was not necessary, however, to close the temporary gate. With a change of weather the river dropped and with it the pool above the dam, and conditions became normal. The ballasting of the flume thus took care of the situation, as planned.

The temporary power plant was equipped with a 54-inch S. Morgan Smith wheel which developed 300 horse-power at 13-foot head. There were two 150 Kw. machines generating current at 440 volts. This was the voltage at the motors in the varions parts of the work and also the voltage for transmitting the current to the dam. For transmission to the work at the permanent power house a mile down the river, the current was stepped up to 6,600 volts.

The Temporary Power Plant



Upper Photograph: Constructing frog in the flume below the dam. *Middle Photograph:* Completed frog with tainter gates in operation. *Lower Photograph:* Upstream from dam site showing diversion cofferdams under construction.

Crusher and Concrete Plant

THE crusher and concrete plant was placed on the west side of the river directly below the quarry which was 400 feet above the river. The location of the quarry and the steep slope down to the dam site permitted a design in which the rock was handled by gravity alone. The quarry rock is shattered basalt. It is made up of the lava flow of past ages from Mt. Adams, 35 miles above. It is good concrete material, and from it was manufactured all the sand as well as the rock.

Both air drill and hand drill gangs were worked in the quarry. The excavated rock was dragged by Bagley scrapers to the crusher chute, after which it was passed through the various operations entirely by gravity. Below the crusher, revolving screens separated the sand and small rock from the large rock, sending it directly to the sand and rock bins, while a portion of the rock went to the hammer mill for further reduction.

Two concrete mixers were installed about 150 feet above the crest of the dam from which height 80 per cent of the concrete was chuted into place. The plant demonstrated a continuous capacity of 10,000 yards a month with two mixers working about ten hours a day. The record run for a day of ten hours was 720 yards.

Upper End of Crusher Plant

The Crusher and Concrete Plant

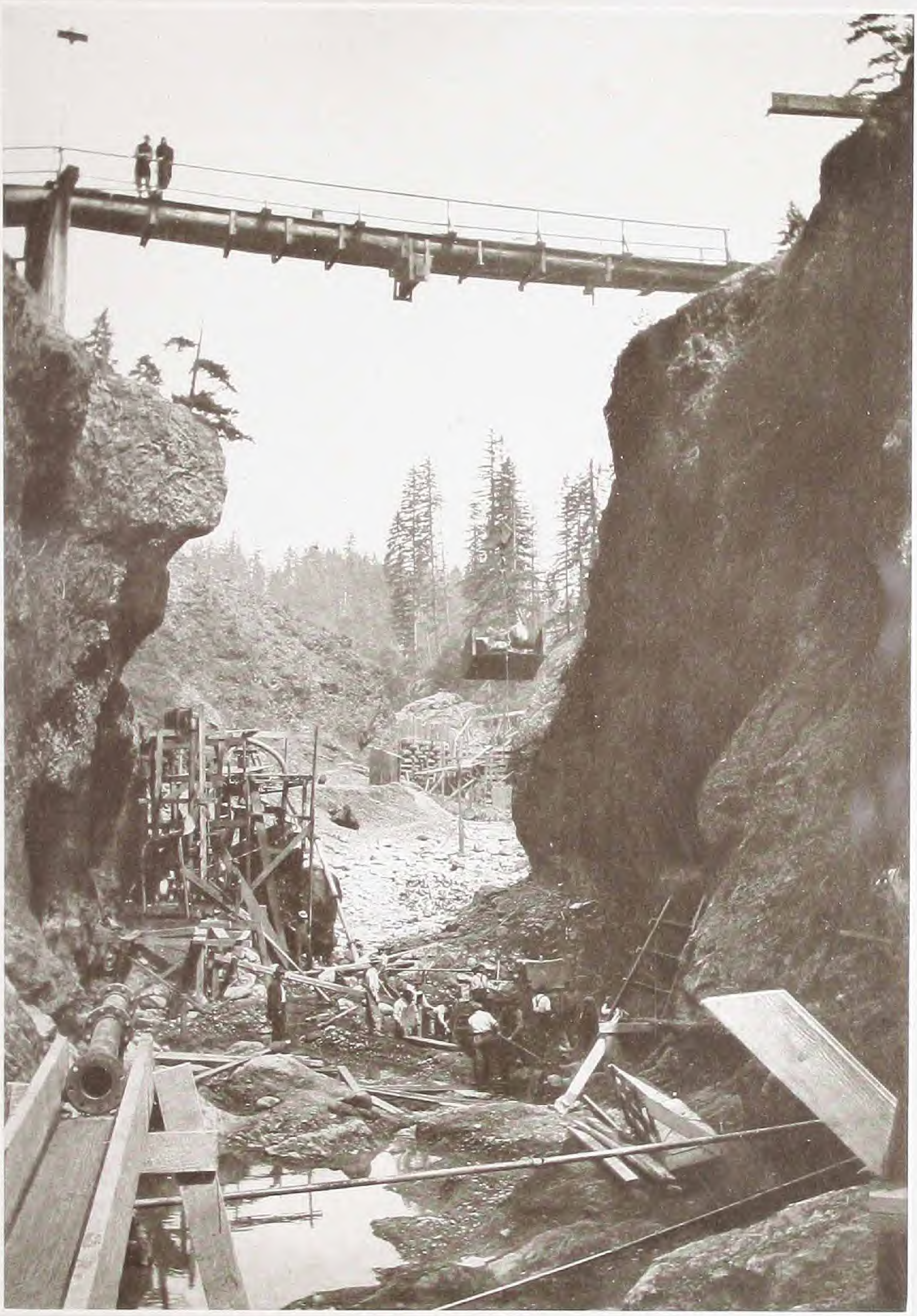
The Dam and Headworks

THE dam contains 30,000 cubic yards of concrete. It is 125 feet at its greatest height and the entire structure, including headworks, is 471 feet in length with a spillway section of 232 feet. The rollway is 88 feet thick at the base. The seal between the concrete and the bed rock is unusually perfect. The bottom is very rough, low on the upstream side, clean and well-broken with the concrete keying into pot holes everywhere.

About 80 per cent. of the concrete was deposited by gravity, being chuted from the crusher plant to a distance of about 285 feet from the west abutment. Of the remaining 20 per cent. part was brought from the crusher plant by cableway to a hopper over the east abutment and there sluiced into place, and part was chuted to a hopper at the middle of the dam and then placed by derrick.

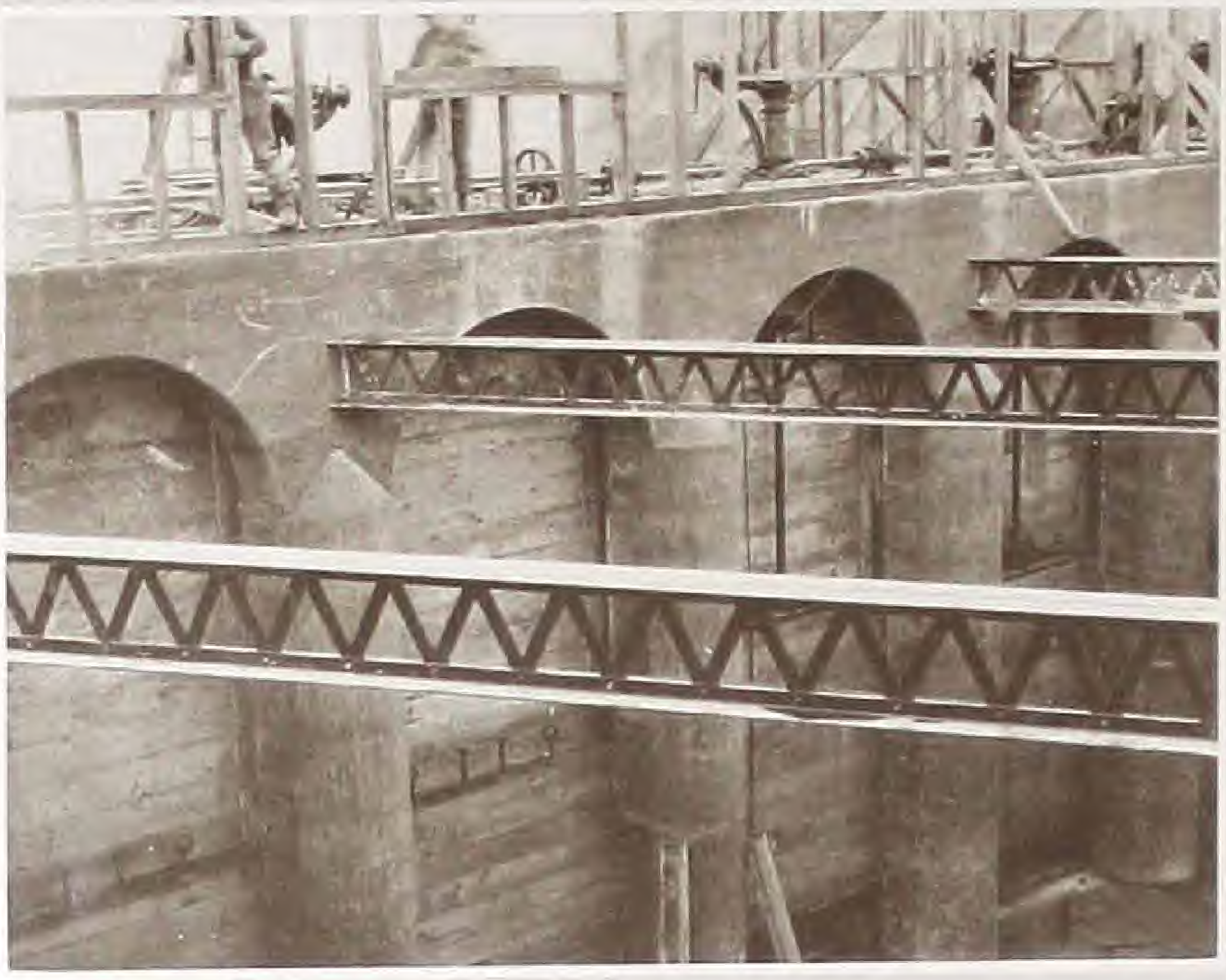
The headworks on the eastern abutment consist of five gates with 8 x 9 foot openings converging into the flow line. The gates are of wood with brass bearing plates and are raised and lowered by valve stands in the gatehouse, so connected by a drive shaft that they can be operated either by machinery or by hand.

Steel Nipple Joining Flow Line with Headworks



The Dam Site

View upstream showing unwatering at the bottom of the gorge with diversion coffer-dams beyond.

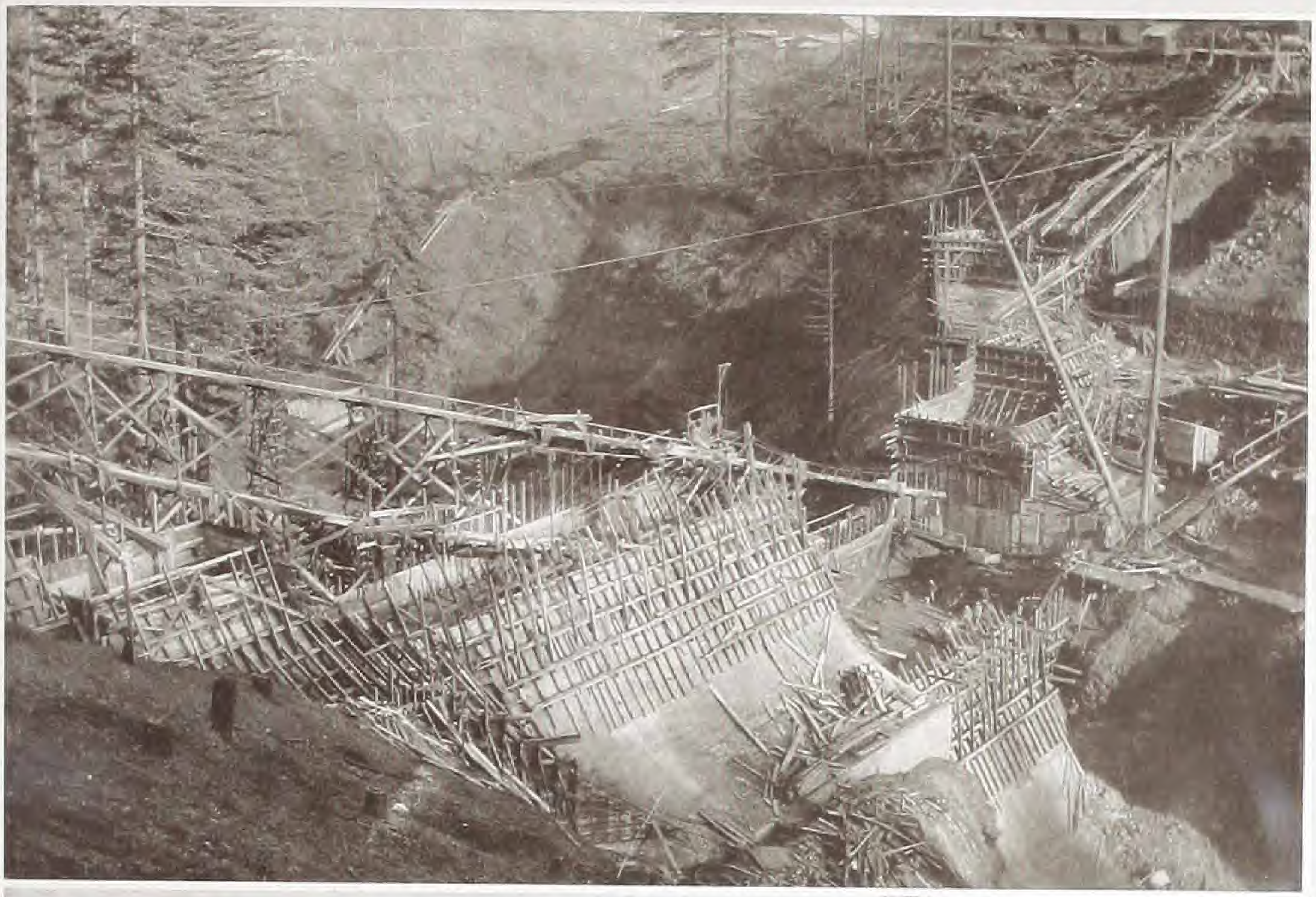


Head Gates

The headworks are provided with ample screen surfaces and a trash sluiceway through which debris gathering in front of the screens is carried over the dam; and an opening is provided on the western abutment for log sluicing. In the gorge, about 150 feet below the crest of the dam, are two 60-inch sluice gates used to carry away deposits of silt which may collect in the bed of the river. The sluice gates are opened and shut by gate stems which run diagonally along the back face of the dam to valve stands on top of the headworks.

The flashboard construction is particularly well adapted to the flow conditions of this river, which, like other Washington streams, is subject to short periods of comparatively high water throughout the year. In order to save as much of the plank as possible during these high water periods, the flashboard pins are so designed that they will fail in sections,—the middle section first, the section on the west side next, and the section on the east side last. The dam is designed on a basis of the maximum flood being 20,000 second feet which would take out all of the flashboards and leave a free crest.

Sluice Gates



The Dam Looking Northeast

Views taken at the height of construction and four months later. Lower photograph shows trash sluiceway on eastern abutment near headworks and log sluiceway on western abutment.

Flow Line and Forebay

WOOD stave pipe, 13 feet 6 inches in diameter, is used for the flow line. It is one mile in length extending along the gorge from the headworks on the eastern abutment of the dam to the forebay near the power house. Over 1,600,000 feet of timber were used. In the pipe proper there are nearly 1,000,000 feet, in the cradles, 476,000 feet, and in the sleepers or mud sills, 210,000 feet. The pipe has 94 staves in its circumference. The total length of staves is nearly 90 miles. It is supported by 1,108 cradles, resting on seven heavy mudsills running the full length of the line.

The stave stock is what is known in the lumber world as No. 2 Douglas, or Washington Fir and is nearly all absolutely clear. It is kiln dried, and planed with beveled edges so that when fitted together the pipe forms a true circle. It comes from a part of Northwestern Washington which is fast being cut and the timber is so good that a great amount of waste does not result, but to get this million feet it is probable that at least 3,000,000 feet of standing timber were cut. In other parts of the State the ratio of stave stock to the cut is higher in some cases running as high as one to six or seven. This lumber came

Completed Flow Line Grade

The Flow Line

View north from top of forebay; crusher plant at the dam site in distance.

Steel Bend

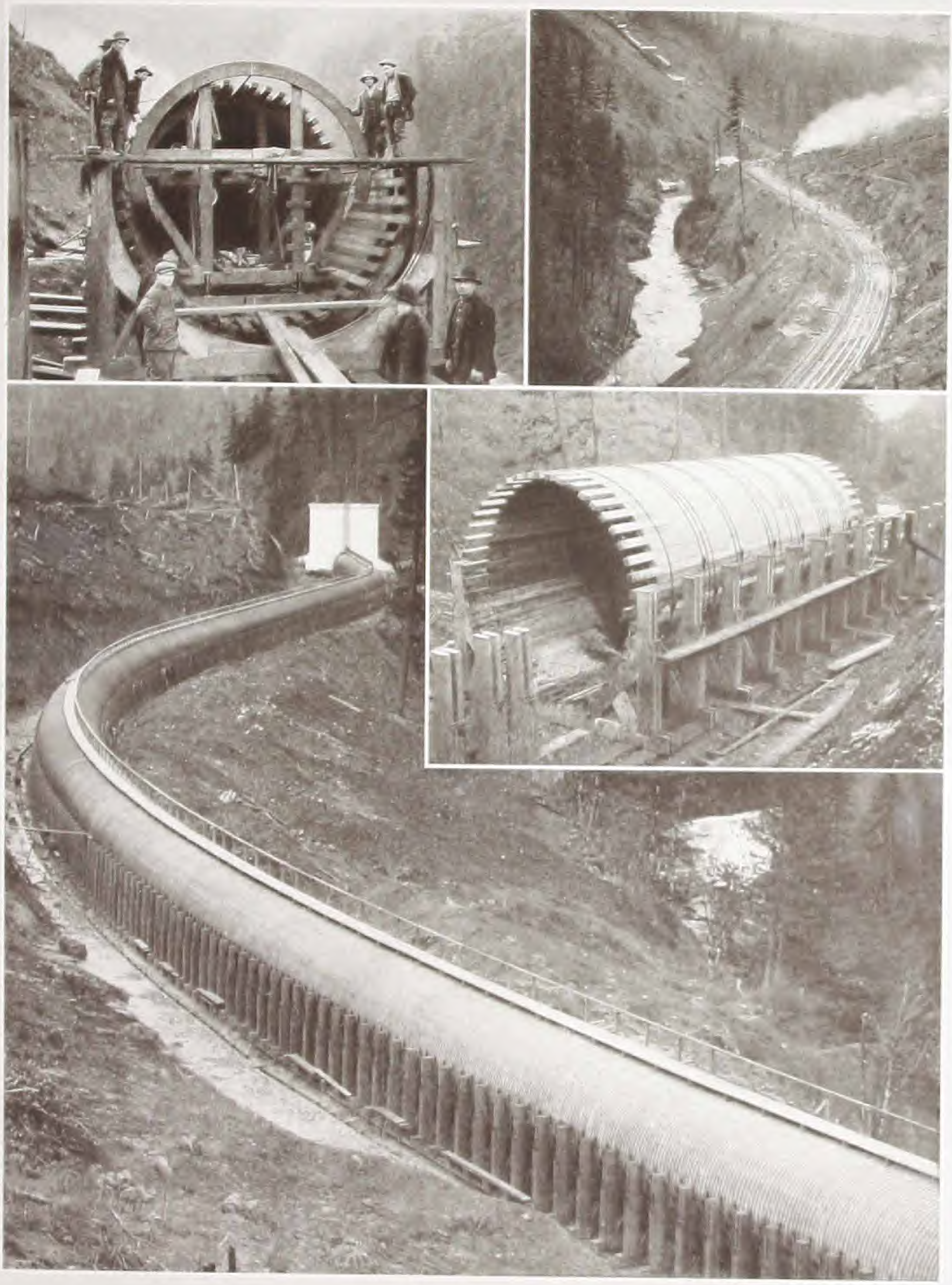
Erecting Steel Plate in Bend

from half a dozen mills each being able to supply only a small amount of the grade required.

While the theory of laying and fitting stave pipe is simple, there is a great knack in fast and workmanlike placing of staves which comes only with experience. One gang erected 180 lineal feet in one day, and on many days 100 feet were erected, while the average in all kinds of weather was not less than 80 feet.

The weight of water in the pipe when full is something like 4 tons per foot, static load, which is more than the weight per foot of length of the heaviest locomotive. Every means was taken, therefore, to make the foundations perfect. The roadbed is all on solid ground, the total excavation being 130,000 yards.

Hauling Plate for Steel Bend



Flow Line Features

Upper Left: Placing flow line staves. *Upper Right:* Pipe line grade showing the heavy longitudinal mudsills. *Center:* Section of completed pipe showing cradles and supporting rods. *Lower:* Flow line and forebay.

Forebay to Tail-Race

THE forebay is a concrete tank 40 feet in diameter, the top being 10 feet above the crest of the dam. The sub-structure is built entirely in cut and of such a shape that the water passes from the flow line to two 9-foot wood stave pressure pipes without change of velocity. Drainage is provided for the sub-structure and an over-flow takes care of excess water during changes in load at the power house greater than the capacity of the relief valves.

From the forebay the pressure pipes drop 160 feet to the power house. They are 650 feet in length, and of wood stave construction to a point near the power house where they join steel sections.

Where they join, the wood staves are lapped 30 inches on the steel and the bands are placed as close as possible. The inside of the steel pipe is the same diameter as the inside of the wood pipe. This produces a slight flare in the staves, which allows the bands to be cinched up, making the joints absolutely tight.

Each unit consists of a pair of turbines of a combined capacity of 10,000 horse-power with a generator of 6,000 Kw. capacity mounted on the shaft between them. Each penstock divides at the power house and connects with the two parts of a unit.

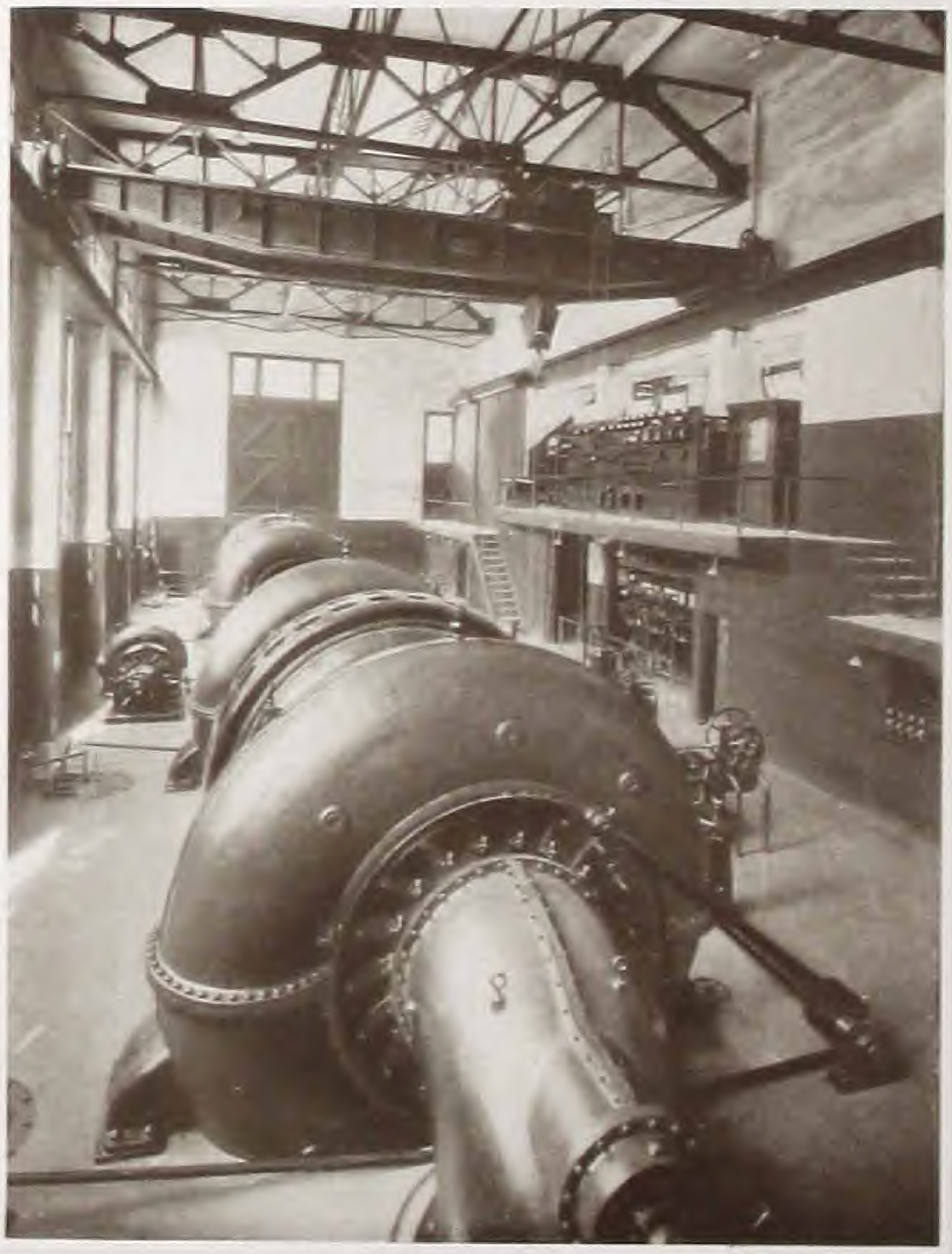
Interior of Forebay

Upper Photograph: Power house excavation and concrete plant. *Lower Left:* Power house from the tail-race excavation. *Lower Right:* Forebay and pressure lines under construction.

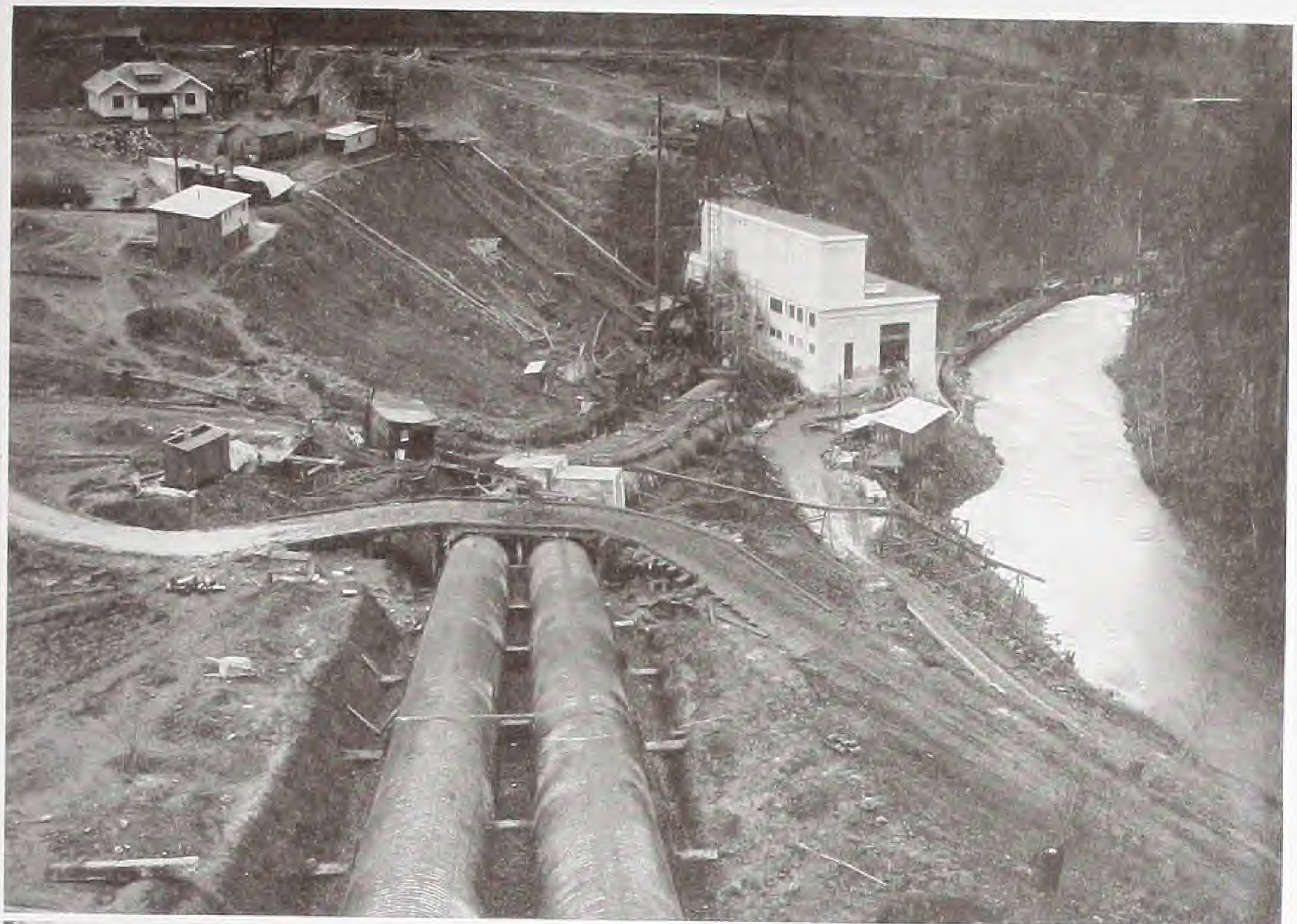
Main and Exciter Units

The material excavated for the sub-structure was hoisted by derricks to an incline tramway which deposited it on the hill above the power house. Other derricks reclaimed it and dumped it into the crusher, where it was broken for concrete aggregate. The rock and sand were chuted down the hill to the mixer, which chuted the concrete into an elevator hopper. The elevator raised it to various heights and chuted it into place to form the power house structure.

The power house is constructed in two general sections running the full length. Overlooking the generator room which faces the river is the switchboard gallery flanked on either side by the transformer cells. The high-tension switches and bus-bars are on the top floor.



Generator Room



The Power House

Upper Photograph: View from top of forebay showing pressure lines. *Lower Photograph*: View from tail-race retaining wall.

Transportation and Labor

MATERIALS and supplies were hauled from Underwood, and in the early part of the work teams and motor trucks were used, each motor being equivalent to twelve teams. When the weather conditions prevented the use of trucks, the force averaged eighty teams. Each team made two trips a day. The heaviest single loads were the lower halves of the stators of the generators, which weighed seventeen tons each. Donkey engines hauled the wagons up the grade out of Underwood, and the rest of the way they were pulled by sixteen horse teams.

When the pipe sections for the lower part of the pressure lines arrived in Underwood, a heavy fall of snow threatened to delay getting them to the job, but sledges were improvised and time was saved by hauling over the snow.

The laboring force varied according to the requirements of the work. For the greater part of the time the average was about 900 men. Towards the end of the job this number was increased to about 1,500.

Material Yards, Underwood